Chapter 2

Cardiovascular Risk Factors and its Transition: An Ongoing Cohort Study in Chinese Kazakhs

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Additional information is available at the end of the chapter

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Abstract

Studies on the prevalence of risk factors and the incidence for cardiovascular diseases (CVDs) are limited in Kazakh population. By incorporating nomads, farmers, and urban residents, aged 30 years or older, in a cohort study, we investigated the characteristics of cardiovascular risk factors and their temporal trends that arose from the urbanization and subsequent changes in the lifestyle in a Kazakh population with 1668 participants. We used current guidelines and the monitoring trends and determinants in cardiovascular disease (MONICA) standard to define cardiovascular events. Kazakhs had a high prevalence rate of hypertension (45.3%), and this prevalence was much higher than the national average in China. Prevalence of two or more risk factors was highest among urban people and lowest among nomads. Urban residents have the highest prevalence of hypercholesterolemia and obesity compared with farmers and nomads. However, unlike other studies, our data indicate that young men had the highest prevalence of dyslipidemia, and it decreased significantly thereafter. Crude rates of incidence and mortality for acute cardiovascular events were 742 and 194 per 100,000 people, respectively; the standardized rates were 926 and 272 per 100,000 people, respectively. The findings from this study demonstrate the pervasive burden of cardiovascular risk factors and the related acute cardiovascular events in Kazakhs, particularly BP in Kazakh nomads.

Keywords: cardiovascular disease, risk factor, cohort, Chinese Kazakhs, registries

1. Introduction

Cardiovascular diseases (CVDs), such as coronary artery disease and stroke, are the major cause of morbidity, mortality, and health expenses in China and worldwide. According to the large international INTERHEART study (1990–2010), the so-called conventional risk factors, such as hypertension, abnormal serum cholesterol, diabetes mellitus, smoking, and obesity, contributed to approximately 90% of CVDs [1, 2]. In China, existing researches on cardiovascular risk factors are largely related to Han people (the largest ethnic group among 56 ethnic groups of China); comprehensive data on cardiovascular risk factors are limited in other minority groups, such as Kazakh people. Knowing the pattern of cardiovascular risk factors among the minority groups is important not only for predicting the future situation of the epidemic and planning relevant policies for prevention and control of CVDs but also for providing new etiological insights through their juxtaposition to known variations in disease patterns.

The Kazakh is a typical transnational ethnic group with a Eurasian lineage. It is the main ethnic group in Kazakhstan and represents a sizable ethnic minority in China and Russia. There are approximately 1.25 million Kazakh people in China, who mainly (96%) live in the Northern Xinjiang Uygur Autonomous region, as a part of the ancient Silk Road. For thousands of years, China's Kazakh people have mainly been active in raising livestock on the prairie grasslands. With urbanization, modern Kazakh people have naturally formed three different subgroups with different occupational backgrounds, that is, nomads following the traditional mode of year-round migration, farmers settling and engaging in agriculture, and urban people transferring to cities with an increased educational level and economic status. In this chapter, we tried to tell a study-based Kazakh story for readers. This study was conducted in Altay, Northern Xinjiang, and China, and we called it as the "China Altay Kazakh Heart Study (CAKH)" study. Its aim was to investigate whether factors such as environmental and occupational changes have an influence on the risk factors and sequent events of CVDs and to quantify morbidity and mortality of CVDs prospectively among Kazakh people.

2. Methods

2.1. Study participants

The CAKH study was initiated in 2012 with a community-based design. Hong Dun town, the study base, is located in the urban-rural fringe of Altay county-level city. As shown in **Figure 1**, 12 Kazakh-based administrative villages and one township office, which almost covered all citizens of this town, were included in this study after excluding villages with less

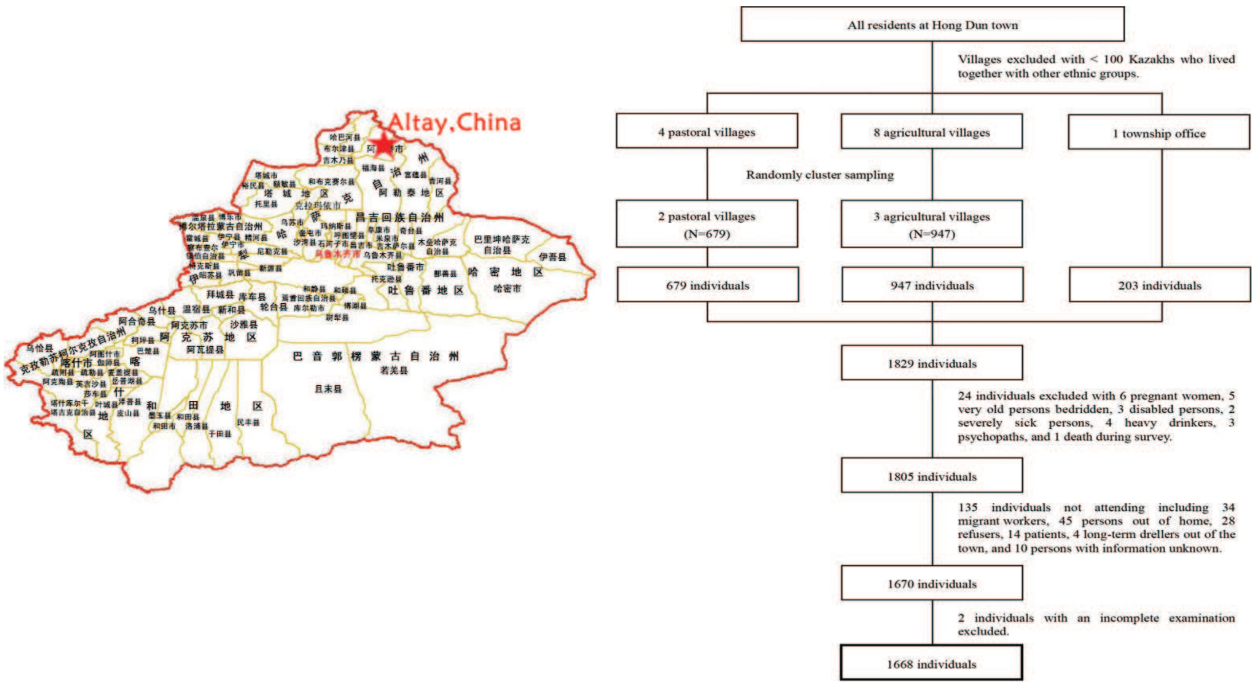

Figure 1. Flow chart of recruitment of participants (also see our previous publication [3]).

than 100 Kazakh individuals who lived together with other ethnic groups. The advantages of Hong Dun town as the study base are that there is a high concentration of Kazakh people, its economic development is representative of the Altay region (one of residence places of Chinese Kazakh with the highest population density), and it includes three natural occupational groups of the Kazakh people, that is, complete nomadic village, farming village, and downtown populations. Using the population census of the area as our sampling frame, a stratified random cluster sampling method was used to select study subjects based on their occupational backgrounds. Samples of potential participants were drawn from two out of four villages characterized by animal husbandry and three out of eight agricultural villages. The entire Kazakh staff affiliated to the township office was recruited into the urban sample. Thus, the final baseline population consisted of five administrative villages (six natural villages) and the downtown professional people, covering 58.4% of the total qualified Kazakh population of the study base of the CAKH study.

All participants included were required to be 30 years of age or older, with at least three generations living in the same region, and were required to have no history of intermarriage. Examinations were performed in the morning, and the elderly or people in remote places were picked up by buses to maximize the participation rate. A participant who had biological Kazakh parents and Kazakh paternal/maternal biological grandparents was considered as a Kazakh. Pregnant women, bedridden persons aged 80 years or older, disabled persons, or persons with severe diseases determined by the investigators were excluded. About 1805 people participated in the survey and 1668 people were completed the survey (see **Figure 1**). This represented 92.4% compliance; specifically, 94.4% (637/675) from pastoral villages, 90.2% (838/929) from agricultural villages, and 96.0% (193/201) from the township office. Their distribution in each sampling unit is displayed in **Table 1**. The overall response rate for completing both the survey and the physical examination was 92.4% (94.4% for pastoral villages, 90.2% for agricultural villages, and 96.0% for urban professional workers). We confirmed that all institutional and governmental regulations concerning the ethical use of human volunteers were followed for this study, which was approved by the Ethical Committees of Chinese Academy of Medical Sciences and Peking Union Medical College.

Village or township office	Occupation	Person number	Men (%)	Age (years, mean (SD))
Kesirjia	Nomads	147	50.3	43.8 (10.4)
Tarstark	Nomads	212	45.8	47.2 (12.7)
Bitiworg	Nomads	278	46.0	47.7 (12.8)
Wutubulak	Farmers	193	47.0	47.9 (12.3)
Sarkamus	Farmers	377	50.9	48.1 (13.3)
Duolart	Farmers	270	47.6	46.3 (12.3)
Township office	Urban people	191	36.3	41.8 (8.9)

Kesirjia and Tarstark are natural villages both affiliated to one administrative village.

Table 1. Participants enrolled in each sampling unit.

2.2. Questionnaire survey

The baseline investigation of the CAKH study was conducted from October 2012 to February 2013 when all nomads would return to their 'home in winter;' this time period included the most important Kazakh holiday, that is, the Corban Festival.

A unified questionnaire was administered through face-to-face interviews conducted by trained and qualified Kazakh medical college students. Information included demographic factors, socioeconomic status (SES) (educational level, marital status, and annual household income), cigarette smoking, alcohol consumption, and information about personal or family history of selected conditions. In addition, based on the characteristics of the Kazakh people, we set up a series of questions about dietary habits. For example, we set four possible responses for vegetable and fruit intake, each category ranging from never or less than once per week to seven or more times per week; we also asked the respondent to give the name and type of the fruit and vegetables they ate. Dietary habits included self-reported volumes of milk-tea consumed (a kind of tea with milk and salt) as well as frequency of consumption of air-dried meats (a kind of meat with salt used as the preservative). Consumption of fruit and vegetables was incorporated into the questionnaire and was coded as more than seven times per week, four to six times per week, one to three times per week, less than once a week, or no fruit and vegetables used.

2.3. Physical examination

Physical examinations included weight, height, and waist circumference measurements, and body mass index (BMI) was calculated as body weight (kg) divided by height (m^2). We used an appropriate arm cuff and a mercury column sphygmomanometer to measure BPs of the left arm in the supine position. Before measurements, a resting period of at least 10 min was required. The mean of two readings or three readings, if there was a difference of more than 5 mmHg between the initial readings, was taken as BP values for the final analysis [4]. A standard 12-lead electrocardiogram (ECG) was conducted for each participant.

2.4. Laboratory measurements

A venous blood sample and a second urine sample after waking were collected from each participant after an overnight fast of at least 10 h, and plasma was immediately separated. All the samples were tested in the central laboratory of the People's Hospital of Altay Prefecture. Total cholesterol (TC), triglycerides (TG), fasting blood glucose (FBG), and creatinine were measured by a standard enzymatic method. Direct determination of concentrations of high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were simultaneously performed. Sodium intake was assessed by urinary sodium excretion from the second urine sample after waking, urinary creatinine concentration, and 24-h urinary creatinine excreted as estimated from height, body weight, and age, as shown in **Table 2** [5]. Daily salt intake was estimated based on a calculation of 24-h urinary sodium excretion on the assumption that all sodium ingested was in the form of sodium chloride, with each 43 mmol of sodium being approximately equivalent to 2.5 g of salt (sodium chloride). Chemistry measurements were made using a Beckman Coulter AU2700 Clinical Chemistry Analyzer (Brea, CA, USA). Electrolytes were measured using a Caretium XI-921 CT Electrolyte Analyzer (Shenzhen, China).

24-h Na excretion (mmol/day) = $16.3 \times \sqrt{(Na_{SMU}/Cr_{SMU}) \times Pr.UCr_{24}}$
Na_{SMU}: Na concentration in second urine sample after waking (mEq/L)
Cr_{SMU}: Cr concentration in second urine sample after waking (mg/L)
$Pr.UCr_{24}$: estimated 24-h urinary Cr excretion (mg/day)
Male Body weight (kg) × 15.1 + Height (cm) × 7.4 − Age × 12.4 − 80
Female Body weight (kg) × 8.6 + Height (cm) × 5.1 − Age × 4.7 − 75
Cr, creatinine

Table 2. Formula for the estimation of the 24-h Na excretion from the data in the second urine sample after waking and estimated Cr excretion.

2.5. Definition of cardiovascular risk factors

Conventional cardiovascular risk factors were defined based on current national guidelines [6]. Hypertension was defined as a systolic BP (SBP) ≥ 140 mmHg, a diastolic BP (DBP) ≥ 90 mmHg, or both, or the use of antihypertensive medications within the last two weeks [6]. Dyslipidemia was defined as total cholesterol (TC) ≥ 6.22 mmol/L, or LDL-C ≥ 4.14 mmol/L, or HDL-C < 1.04 mmol/L, or TG > 2.26 mmol/L, or receiving cholesterol-lowering medication [7]. Obesity was defined as a BMI ≥ 28.0 (kg/m^2). Diabetes mellitus was defined as fasting blood glucose concentration ≥ 7.0 mmol/L or taking hypoglycemic agents. Current smokers were defined as those who had smoked at least one cigarette each day during the past year [8]. Women who consume one or more alcoholic drinks per day and men who consume two or more alcoholic drinks per day were considered as current alcohol drinkers.

2.6. Collection of acute cardiovascular events

This ongoing prospective cohort study currently completed the first collection of acute cardiovascular events from October 1, 2012 through June 30, 2016 in 1668 participants. The next follow-up is being planned. Acute cardiovascular events included stroke, acute myocardial infarction (AMI), and sudden cardiac death (SCD). Stroke and AMI could be fatal or nonfatal. Stroke events were defined as rapidly developing signs of focal (or global) disturbance of cerebral function lasting 24 hours (unless interrupted by surgery or death) with no apparent nonvascular cause according to the World Health Organization (WHO) MONICA standard [9]. On the basis of the status within 28 days of onset, stroke and AMI events were subdivided into first or recurrent and into fatal or nonfatal. The 2012 universal definition of myocardial infarction was used for AMIs [10]. Considering a factual situation of monitoring cardiovascular diseases, AMIs were classified into definite or possible/insufficient ones particularly for fatal cases according to MONICA standard, with deaths due to chronic coronary heart diseases excluded [9, 11]. An SCD is defined as sudden and unexpected death within an hour of symptom-onset after excluding participants whose sudden deaths were likely due to a known noncardiac cause, such as a large pulmonary embolism that could result in cardiac arrest or malignancy that is not in remission. If unwitnessed, subjects should have been observed alive within 24 hours of their deaths [12]. The WHO's International Classification of Diseases, the

10th revision (ICD-10) was used in this study. The code of I60–I64 was for stroke, including hemorrhagic (I60–I62), ischemic (I63), and nonspecified stroke (I64). The code of cardiac events included I21–I22 for acute myocardial infarction and I46.1 for sudden cardiac death. Information on demographic characteristics, diagnosis such as imaging, markers of myocardial injury, and electrocardiogram, and time of event onset and death was also collected. In addition, for a high quality of registration of acute cardiovascular events, information on all deaths within this period were recorded, such as underlying and direct causes of all deaths, the place and time of death, diagnoses and related evidence, and so on. Discharge records were mainly used to qualify diagnoses, and for patients who did not visit the clinics of local hospitals, any other medical records and inquires by doctors were employed.

Three survey stages for collecting acute cardiovascular events, that is, a hospital-based search and reading of medical records of inpatients in all four local hospitals (i.e., the People's Hospital of Altay Prefecture, the People's Hospital of Altay City, the 16th People's Liberation Army Hospital, and the Kazakh Hospital of Altay), a supplementary registration from village physicians, and a survey for reducing false negatives, were included in this work. On August 10–12, 2016, we visited the departments responsible for medical records in these four hospitals. We searched all files indexed by discharge date, residence, and ICD-10 codes. After excluding some files according to ethnics, names, and age, an expert committee including clinical doctors and public health doctors read medical courses, judged an acute cardiovascular event, and filled an event card out. On August 11, 2016, we trained all related village physicians who were responsible for collecting clues on the occurrence of acute cardiovascular events in selected subjects. On August 15, 2016, these clues were submitted to the expert committee. For patients with a history of hospitalization, a reading of medical records and a judgment for identifying acute cardiovascular events were done; for the ones not hospitalized or whose deaths occurred at home, a detailed inquiry was conducted for the relatives of patients and related village physicians. Also, electronic files of medical insurance were used to search related cases. No loss to follow-up was found. On August 26, 2016, with checking the preliminary results of collection, we found zero events identified in the township office, thereafter a recheck was done by telephone through village physicians.

2.7. Statistical analysis

Initially the distribution of each cardiovascular risk factor was examined among three groups by gender. We calculated the prevalence with 95% confidence intervals for binary variables and means with standard deviations for continuous variables; medians (interquartile range) are presented for triglycerides and fasting blood glucose since these data were positively skewed. All reported values (means, prevalence) were adjusted for age using linear regression or logistic regression models. We assessed trends in educational attainment and economic measures by fitting regression models for each outcome and performing the Wald test on model parameters. The incidence refers to all events, first or recurrent and nonfatal or fatal, within one year per 100,000 people, and mortality rate is the number of fatal events within 28 days per 100,000 people [9]. The incidence and mortality were standardized with the weights from distribution of age and gender in the Sixth National Census of China conducted in 2010. A Chi square test was used to compare difference of groups for

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qualitative data. All P-values were two-sided except P trend tests based on nonconditional logistic method, in which one-sided P values were used, and a P-value < 0.05 was considered statistically significant. All analysis was conducted with the use of SAS 9.2 Version (Institute, Inc., Cary, NC, USA).

3. Results

In general, the farmer group had the highest proportion (50.2%) of the participants and the eldest median age (45; range 30–85 years), followed by the nomad group (the proportion was 38.2% and median age 44; range 30 to 88 years) and the urban group had the lowest participating proportions (11.6%) and the youngest median age (39; range 30 to 78 years). About 24.5% of the participants had a high school education or higher, 88.1% were married and living with a spouse, and 41.2% had annual family income between 10,000 and 40,000 RMB. Basic medical insurance covered almost all of the participants (97.8%). The study population was relatively stable with a mobile population (migrant workers) of 1.9%. The characteristics of the participants in each subgroup by gender are shown in **Table 3**.

	Nomads			**Farmers**			**Urban group**		
	Men	**Women**	**Total**	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**
No.	299	338	637	410	428	838	70	123	193
Age (years, Mean (SD))	46.6 (12.2)	46.6 (12.5)	46.6 (12.3)	46.9 (12.3)	48.3 (13.1)	47.6 (12.7)	43.5 (10.0)	40.8 (8.0)	41.8 (8.9)
Education (years, mean (SD))									
≤Primary school	124 (41.6)	138 (41.1)	262 (41.3)	114 (28.0)	125 (29.3)	239 (28.7)	1 (1.4)	1 (0.8)	2 (1.0)
Middle school	145 (48.7)	164 (48.8)	309 (48.7)	227 (55.8)	200 (46.8)	427 (51.2)	6 (8.6)	10 (8.1)	16 (8.3)
High school or above	29 (9.7)	34 (10.1)	63 (9.9)	66 (12.2)	102 (23.9)	168 (20.1)	63 (90.0)	112 (91.1)	175 (90.7)
Marital status									
Married	267 (89.6)	287 (85.4)	554 (87.4)	362 (88.9)	370 (86.7)	732 (87.8)	68 (97.1)	110 (89.4)	178 (92.23)
Other*	31 (10.4)	49 (14.6)	80 (12.6)	45 (11.1)	57 (13.4)	102 (12.2)	2 (2.9)	13 (10.6)	15 (7.8)
Annual family income (RMB)									
<10 000	163 (54.9)	192 (57.5)	355 (56.3)	228 (56.2)	259 (61.7)	487 (59.0)	11 (15.7)	24 (19.5)	35 (18.1)
10 000–40 000	117 (39.4)	132 (39.5)	249 (39.5)	163 (40.2)	150 (35.7)	313 (37.9)	45 (64.3)	72 (58.5)	117 (60.6)
≥40 000	17 (5.7)	10 (3.0)	27 (4.3)	15 (3.7)	11 (2.6)	26 (3.2)	14 (24.0)	27 (22.0)	41 (21.2)

	Nomads			Farmers			Urban group		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Medical insurance									
Yes	295 (99.0)	324 (96.4)	619 (97.6)	399 (98.3)	419 (98.1)	818 (98.2)	69 (98.6)	118 (95.9)	187 (96.9)
No	3 (1.0)	12 (3.6)	15 (2.4)	7 (1.7)	8 (1.9)	15 (1.8)	1 (1.4)	5 (4.1)	6 (3.1)
Go out for work in past year									
Yes	8 (2.7)	2 (0.6)	10 (1.6)	20 (4.9)	5 (1.2)	25 (3.0)	5 (7.1)	5 (4.1)	10 (5.2)
No	285 (95.3)	333 (98.5)	618 (97.0)	381 (93.0)	415 (97.0)	796 (95.0)	64 (91.4)	118 (95.9)	182 (94.3)

*Separated, divorced, or widowed. Data on marital status, annual family income, medical insurance, and going out for work in the past year are person numbers (percents) of participants.

Table 3. Descriptive characteristics for Kazakh participants by occupational background and by gender.

3.1. Distribution of cardiovascular risk factors

Table 4 shows the distribution of cardiovascular risk factors by occupational categories and by gender. We observed a significantly diverse pattern between groups for the risk factor measurements. Nomad men and women had the highest mean levels of SBP and DBP, TC, LDL-C, HDL-C, and FBG, followed by the farmer group, and the urban men and women had the lowest level in most subgroups (all $P < 0.001$). The main exceptions were for BMI and TG level where an opposite trend was observed. Compared with nomads and farmers, urban people, both men and women, had the highest mean level of BMI and TG though there was less statistical significance in the trend in TG level among urban women.

Age-adjusted prevalence of cardiovascular risk factors by occupational backgrounds and by gender is presented in **Figure 2**. The overall prevalence (95% CI) of hypertension was 50.0% (49.0%, 51.1%) among men and ranged from 47.1% (44.3%, 49.9%) (urban men) to 54.2% (52.5%, 55.8%) (nomad men). In women, prevalence of hypertension was 41.1% (39.3%, 42.8%) and ranged from 22.8% (19.2%, 26.3%) (urban women) to 47.0% (44.2%, 49.9%) (nomad women). Nomad group, both men and women, had the highest rates of hypertension (all $P < 0.001$). Overall, 39.4% (38.9%, 39.9%) of men had dyslipidemia; dyslipidemia prevalence ranged from 37.5% (37.2%, 37.7%) (nomad men) to 55.7% (53.9%, 57.5%) (urban men). Overall prevalence of dyslipidemia among women was 24.1% (23.8%, 24.4%), which ranged from 23.4% (22.7–24.0%) (nomad women) to 30.1% (29.7%, 30.4%) (urban women). Urban group, both men and women, had the highest rates of dyslipidemia (all $P < 0.001$). About 26.2% (26.1, 26.3%) of men were obese; prevalence of obesity ranged from 24.4% (24.1%, 24.6%) (farmer men) to 41.4% (40.3%, 42.5%) (urban men). Among women, overall prevalence of obesity was 37.8% (37.3%, 38.2%). Prevalence of obesity was the highest (44.7%) (42.5%, 46.9%) for urban women the lowest 33.7% (32.9%, 34.5%) for nomad women. Urban group, both men and women, had the highest rates of obesity (all $P < 0.001$). Overall, 1.9% (1.8%, 2.0%) of men and 1.2% (1.1%, 1.3%) of women had diabetes mellitus, ranging from 1.2% (1.1%, 1.3%) in farmer men to 2.9% (0.9%, 4.8%) in urban men and from 0.7% (0.6%, 0.8%) in farmer women

	Men				Women			
	Nomad (n=299)	**Farmer (n=410)**	**Urban people (n=70)**	***P* for trend***	**Nomad (n=338)**	**Farmer (n=427)**	**Urban people (n=123)**	***P* for trend***
Mean (SD) SBP (mmHg)	140.8 (23.0)	135.9(20.9)	132.2 (16.7)	0.001	138.2 (27.1)	134.3 (26.1)	125.8 (19.6)	< 0.001
Mean (SD) DBP (mmHg)	88.5 (13.8)	85.3 (12.8)	85.7 (11.8)	0.005	85.3 (14.2)	82.2 (12.8)	81.2 (11.8)	0.001
Mean (SD) BMI (kg/m^2)	25.6 (4.4)	25.5 (4.1)	27.1 (4.6)	0.011	26.5 (5.2)	27.1 (5.1)	27.5 (4.3)	0.085
Mean (SD) TC (mmol/L)	5.40 (0.94)	5.18 (0.94)	5.31 (1.01)	0.009	5.08 (0.91)	4.95 (0.96)	4.60 (0.81)	< 0.001
Mean (SD) LDL-C (mmol/L)	3.27 (0.61)	3.02 (0.60)	3.22 (0.64)	<0.001	3.10 (0.60)	2.92 (0.61)	2.76 (0.50)	< 0.001
Mean (SD) HDL-C (mmol/L)	1.42 (0.42)	1.33 (0.35)	1.26 (0.54)	0.001	1.48 (0.40)	1.43 (0.33)	1.24 (0.29)	< 0.001
Median (IQR) TG (mmol/L)	0.87 (0.62, 1.30)	0.94 (0.71, 1.43)	1.29 (0.91, 2.27)	0.002	0.76 (0.58, 1.03)	0.82 (0.58, 1.11)	0.82 (0.62, 1.10)	0.647
Median (IQR) FBG (mmol/L)	5.34 (5.03, 5.64)	5.24 (4.95, 5.53)	4.98 (4.74, 5.33)	0.026	5.17 (4.89, 5.44)	5.08 (4.78, 5.37)	4.90 (4.64, 5.22)	0.107

**P* values were obtained by fitting regression models with risk factors as the outcome and performing Wald tests on model parameters (logistic regression was used for binary variables and linear regression for continuous variables).

SD: standard deviation; IQR: interquartile range; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; BP: blood pressure.

Table 4. Levels of BP, blood lipid, and fasting blood glucose in Kazakhs of three occupational backgrounds by gender.

to 3.3% (2.0%, 4.5%) in urban women, respectively; urban men and women had the highest diabetes prevalence (all $P < 0.001$). About 55.6% (54.9%, 56.4%) of men were current smokers, with highest prevalence of smoking among urban men (62.9, 61.8–63.9%) and lowest among farmer men (54.2, 53.0–55.4%). Overall, the prevalence of current smoking in women was low (2.6%, 2.5% to 2.7%); the highest prevalence of smoking was 4.4% (4.3%, 4.7%) among nomad women and the lowest was 1.4% (1.3%, 1.5%) among farmer women (all $P < 0.001$). These rates were largely unchanged when standardized to the Kazakh general population in 2010.

Table 5 shows the age- and occupation-adjusted prevalence of cardiovascular risk factors by SES. For men, hypertension was more common in the lower educational attainment (ranged from 55.6 to 44.9% from low to high level) and lower annual family income (ranged from 55.9 to 46.1%) group, whereas dyslipidemia and obesity were more common in the higher educational attainment (from 34.3 to 55.1% for dyslipidemia; 12.2 to 22.8% for obesity) and economic level group (from 37.3 to 44.5% for dyslipidemia; 13.1 to 18.9% for obesity), both showed a significant linear gradient relationship (all $P < 0.01$). Similar to men, hypertension

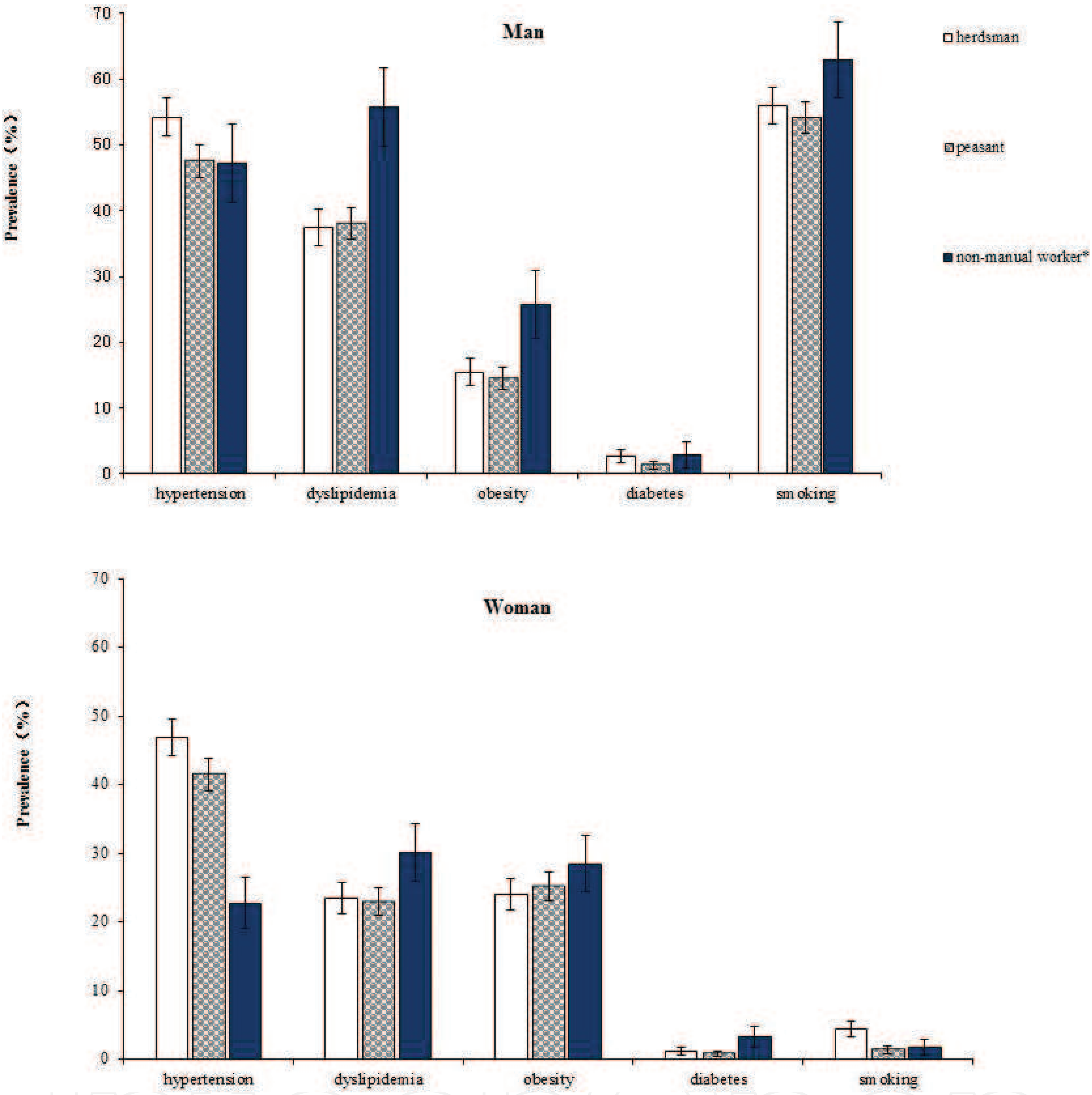

Figure 2. Prevalence of adverse cardiovascular disease risk profiles for all participants by occupational backgrounds and gender. *Risk factors: Hypertension was defined as systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or receiving treatment; Dyslipidemia was defined as total cholesterol (TC) ≥ 6.22 mmol/L, or LDL cholesterol ≥ 4.14 mmol/L, or HDL cholesterol < 1.04 mmol/L, or TG >1.70mmol; Obesity was defined as a body mass index ≥ 28 kg/m^2; Diabetes mellitus was defined as fasting blood glucose concentration ≥ 7.0 mmol/L or take hypoglycemic agents; Smoking was defined as currently smoking cigarettes. Values were adjusted for age. Error bars indicate 95% CIs (also see our previous publication [12]).

in women was found to be more common in lower educational level and lower annual family income group (the prevalence from 59.1 to 25.0% following an increasing educational level; from 51.8 to 37.8% following an increasing annual family income level, all $P < 0.001$), but there was no such trend in the distribution of dyslipidemia with SES. There was no significant trend in other risk factors' distribution with regard to the level of SES.

	Men's educational level †				**Women's educational level †**			
	Low (n=239)	**Middle (n=378)**	**High (n=158)**	**P for trend**	**Low (n=338)**	**Middle (n=427)**	**High (n=123)**	**P for trend**
Hypertension (%)	55.6 (49.4, 61.9)	48.7 (43.6, 53.7)	44.9 (37.2, 52.7)	0.030	59.1 (53.2, 65.0)	38.8 (33.8,43.7)	25.0 (19.6, 30.4)	<0.001
Dyslipidemia (%)	34.3 (28.3, 40.3)	36.2 (31.4, 41.1)	55.1 (47.3, 62.8)	< 0.001	26.9 (21.5, 32.2)	23.8 (19.5, 28.1)	21.8 (16.6, 26.9)	0.175
Obesity (%)	12.2 (8.1, 16.4)	15.3 (11.7, 19.0)	22.8 (16.2, 26.3)	0.007	26.7 (21.4, 32.0)	25.9 (21.5, 30.4)	22.6 (17.4, 27.8)	0.298
Diabetes (%)	1.3 (0.0, 2.7)	2.6 (1.0, 4.3)	1.3 (0.5, 3.0)	0.834	1.1 (0.0, 2.4)	1.3 (0.2, 2.5)	1.2 (0.0, 2.6)	0.937
Smoking (%)	50.2 (43.9, 56.5)	59.0 (54.0, 64.0)	56.3 (48.6, 64.1)	0.148	1.9 (0.2, 3.5)	3.7 (1.8, 5.7)	1.6 (0.0, 3.2)	0.871
	Men's annual family income ‡				Women's annual family income‡			
	Low (n=299)	Middle (n=410)	High (n=70)	*P*	Low (n=338)	Middle (n=427)	High (n=123)	*P*
Hypertension (%)	55.0 (47.5, 62.5)	53.2 (46.8, 59.6)	46.1 (41.0, 51.2)	0.034	51.8 (44.2, 59.4)	38.5 (33.1, 43.9)	37.8 (33.1, 42.6)	0.006
Dyslipidemia (%)	37.3 (30.0, 44.6)	33.5 (27.4, 39.5)	44.5 (39.4, 49.5)	0.041	25.3 (18.7, 31.9)	20.7 (16.2, 25.2)	25.9 (21.6, 30.2)	0.567
Obesity (%)	13.1 (8.0, 18.2)	13.4 (9.0, 17.7)	18.9 (14.9, 22.8)	0.053	27.1 (20.3, 33.9)	23.0 (18.3, 27.7)	26.0 (21.7, 30.3)	0.999
Diabetes (%)	2.4 (0.1, 4.7)	3.0 (0.8, 5.2)	1.1 (0.0, 2.1)	0.198	1.2 (0.0, 2.9)	1.0 (0.0, 2.1)	1.5 (0.3, 2.7)	0.677
Smoking (%)	58.0 (50.5, 65.4)	56.7 (50.3, 63.0)	54.2 (49.1, 59.2)	0.380	2.4 (0.1, 4.7)	2.9 (1.0, 4.8)	2.2 (0.8, 3.7)	0.793

Percents (95% CIs) were adjusted for age and occupational background.

†Educational level was defined as: low ≤ primary school middle: middle school; high: high school or above.

‡Annual family income (RMB) was defined as: low: < 10,000; middle: 10,000–40, 000; and high: ≥ 40,000(RMB).

Table 5. The prevalence of CVD risk factors by socioeconomic position and by gender among Kazakh participants.

Overall, 33.2% of men had a level of any one major risk factor only (most commonly smoke, 50.8%); 35.3% and 21.1% of men had any 2 only or 3 or more risk factors, as shown in **Figure 3**. Prevalence of 3 or more risk factors was highest among urban men (30.0%) and lowest among nomad men (20.1%) ($P < 0.001$). Among women, 33.3% had one risk factor only (most commonly hypertension, 44.3%); 24.3% and 8.1% had any 2, 3, or more risk factors. Prevalence of three or more risk factors was the highest among urban women (11.4%) and lowest among nomad women (6.5%) ($P < 0.001$). A significantly higher proportion ($P < 0.001$) of men than women had three or more risk factors. Prevalence of three or more risk factors was significantly higher ($P < 0.001$) with lower annual family income and lower education attainment (women only). The respective prevalence in men and women ranged from 48.9% and 52.9% for low family income group to 6.1% and 7.4% for high level family income group; and the respective prevalence ranged from 44.4 to 22.2% for women from low to high level of education ($P < 0.001$), but this trend revealed opposite for men with 20.7 and 28.7% from low to high level of education ($P < 0.05$).

In addition, we estimated 24-h salt intake of 17.6 ± 14.2 g/d in this population. This value was 17.6 (16.8), 16.9 (12.7), and 20.7 (9.8) g/d in these three occupational groups, respectively. Though high dietary salt intake was not associated with occupational background, a significant association of salt intake with BP level was observed among 1445 participants (86.6%) who did not take antihypertensive medication, as shown in **Figure 4**. This association on

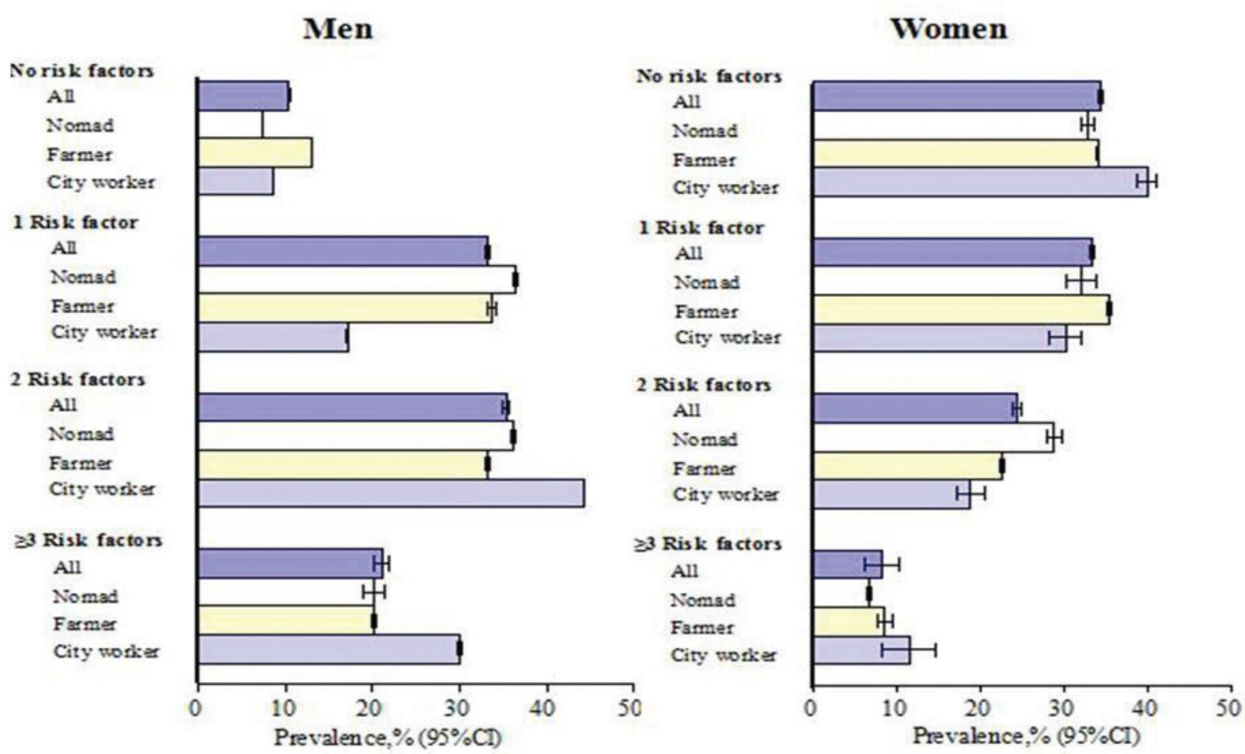

Figure 3. Comparison of profiles of risk factors by occupational backgrounds in men and women (also see our previous publication [12]).

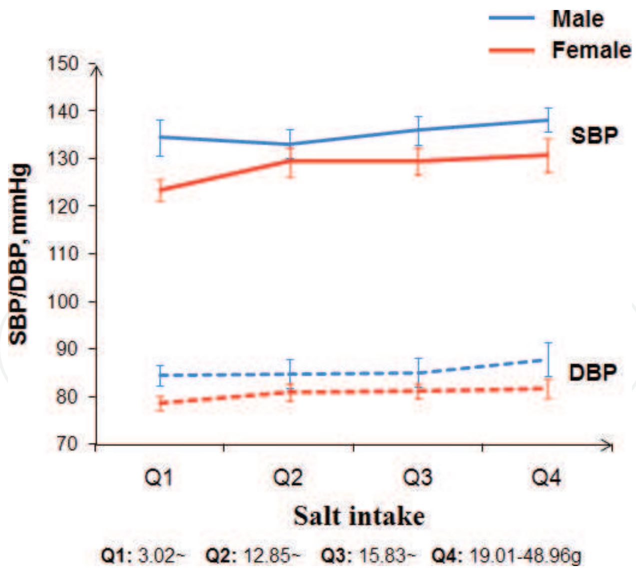

Figure 4. Estimated salt intake and BP in Kazakh people not taking antihypertensives (n = 1445).

high BP prevalence was also found when using a nonconditional logistic model (**Table 6**). A significantly increased prevalence for high BP was observed in the top quartile of urinary sodium excretion compared with the bottom quartile across the three different models. However, the strength of the association decreased after adjusting for potential confounding factors. In model 1 (adjusted for age only), ORs were 1.83 (95% CI: 1.19–2.83) and 2.38 (95% CI: 1.43–3.96) for men and women, respectively, in Q4 urinary sodium compared with Q1 (model 1). When the model was adjusted for residence, educational level, alcohol consumption, smoking, BMI, and fruit and vegetable consumption, the association between urinary sodium and prevalence for high BP attenuated, with ORs being 1.61 (95% CI: 1.02–2.54) for men and 1.92 (95% CI: 1.13–3.27) for women. Moreover, we found a much poor situation in people with controlled hypertension (2.9% for a BP control and 10.1% for a BP control under medication). There was an obviously increasing trend on treatment and control of hypertension following a sequence of nomads, farmers, and urban people, though this trend was not significant on control of hypertension (**Table 7**).

3.2. Occurrence of acute cardiovascular events

Forty-two cases with 46 acute cardiovascular events, including 7 acute myocardial infarctions, [14] 3 sudden cardiac deaths, and 36 incident strokes, were found. Among these events, there were four patients experiencing multiple acute cardiovascular events: one patient with two concurrent events, subarachnoid hemorrhage (SAH) and AMI; one patient with a nonfatal AMI and an in-hospital SCD after 31 days of the AMI occurrence; and two patients with ischemic stroke followed by another ischemic stroke or SAH after 28 days of the first stroke. All nonfatal AMIs had diagnostic evidence of markers of myocardial injury and ECG. 3 fatal cases were classified as possible AMIs with insufficient data. Besides one in-hospital SCD, 2 out-of -hospital SCDs were unwitnessed at the occurrence of death but observed alive within 24 hours from their death. All strokes, hemorrhagic or ischemic, had evidence of computed tomography (CT)

	Adjusted OR (95% CI) by gender	
	Men	**Women**
Model 1 adjusted for age		
Q1	1.00	1.00
Q2	1.05 (0.68,1.63)	1.58 (0.93,2.68)
Q3	1.06 (0.69,1.63)	1.66 (1.00,2.80)
Q4	1.83 (1.19,2.83)	2.38 (1.43,3.96)
Model 2 adjusted for age, occupation, and educational level		
Q1	1.00	1.00
Q2	1.05 (0.68,1.63)	1.38 (0.81,2.37)
Q3	1.95 (0.68,1.63)	1.45 (0.85,2.47)
Q4	1.81 (1.17,2.79)	2.06 (1.22,3.47)
Model 3 adjusted for age, occupation, educational level, body mass index, current smoker, current drinker, fruit consumption and vegetable consumption		
Q1	1.00	1.00
Q2	1.01 (0.64, 1.60)	1.29 (0.74, 2.23)
Q3	0.98 (0.62, 1.54)	1.30 (0.75, 2.24)
Q4	1.61 (1.02, 2.54)	1.92 (1.13, 3.27)

Table 6. Relationship between estimated salt intake and high BP (also see our previous publication [13]).

	Percent (95% CI)			
	Awareness	**Treatment**	**Controlled**	**Medication-controlled**
Nomad	60.7 (59.3–62.0)	24.8 (22.9–26.6)	2.2 (2.0–2.3)	8.8 (8.4–9.1)
Farmer	62.7 (61.5–63.9)	31.4 (29.4–33.3)	3.2 (3.1–3.4)	10.3 (9.9–10.6)
Urban people	52.5 (49.5–55.4)	34.4 (29.5–39.3)	4.9 (4.3–5.5)	14.3 (13.3–15.3)
P for trend	0.410	0.002	0.082	0.237
Total	61.0 (60.2–61.9)	28.8 (27.5–30.1)	2.9 (2.8–3.0)	10.1 (9.8–10.4)

Table 7. Awareness, treatment, and control of hypertension.

or magnetic resonance imaging (MRI). There were two cases with nonspecified stroke that was identified according to clinical manifestation. During this study, 31 deaths were found in 1668 individuals including 19 CVD underlying deaths (61.2%). Among 42 events, 17 deaths were followed in which 12, including 3 SCDs (I46.1), 2 SAHs (I60), 2 hemorrhagic strokes (I61), 2 acute cerebrovascular accidents (I64), and 3 coronary deaths with insufficient data, happened within 28 days after CVD occurrence.

In the electronic search for medical records in hospitals, repeated in-hospital records, particularly for nonacute ischemic stroke (I63), were common. One among the ischemic strokes listed in the second diagnosis, the first diagnosis being primary hypertension (stage 3), was identified as an acute event only. **Table 8** displays a comparison of the detailed search course for available files between the People's Hospital of Altay Prefecture and the People's Hospital of Altay City. Few AMIs shown in the People's Hospital of Altay City were in accordance with its ability for treating CVDs, dramatically different from most strokes likely due to a policy of referrals; this finding should be compared with the People's Hospital of Altay Prefecture, which ranks the highest in the Altay region. The number of events found in the People's Hospital of Altay Prefecture, the People's Hospital of Altay City, the 16th People's Liberation Army Hospital, and the Kazakh Hospital of Altay was 20, 7, 0, and 1, respectively; another 18 events (39.1%) were supplemented in the community. Among these 18 events, 5, 4, 1, 0, and 2 events were diagnosed in the four hospitals above and a tertiary hospital in Urumqi, Capital of Xinjiang, respectively, and 2, 1, and 3 events were classified as SCD, acute cerebrovascular accidents, and AMI with insufficient data, respectively. The proportion of fatal events supplemented by communities was significantly higher than that registered by hospitals (75.0% vs. 26.5%, $P = 0.003$). The ratio of events was 3.6:1 for stroke and cardiac events and this ratio was 1.6:1 for ischemic or hemorrhagic strokes. The detailed results are shown in **Table 9**.

A variation from the incidence of acute cardiovascular events following time and place is shown in **Table 10**. The incidence increased following time with a statistical significance ($P < 0.001$). As no events were identified in the township office and its adjacent Wutubulak village, we rechecked the information from the office by telephone through village physicians;

Search aim	The hospital of prefecture (Jan 2014–July 2016)		The hospital of city (Oct 2013–July 2016)	
	Records	Events	Records	Events
I21	1	0	0	0
I22	0	0	1	0
I46.1	0	0	0	0
I60	3	1	0	0
I61	10	4	4	0
I62	0	0	0	0
I63	13	5	114	5
I64	0	1	3	0
All-cause deaths	2	0	2	0

Table 8. Results of a search for medical records in 2 major hospitals, Altay.

CVD event	Hospital-based number (%)	Community-based number supplemented (%)	Total
Disease category			
Acute cardiac event			
Acute myocardiac infarction (I21~I22)	4 (57.1)	3 (42.9)	7
Sudden cardiac death (I46.1)	1 (33.3)	2 (66.6)	3
Subtotal	5 (50.0)	5 (50.0)	10
Acute stroke event			
SAH (I60)	1 (50.0)	1 (50.0)	2
Intracerebral hemorrhage (I61)	8 (62.7)	3 (27.3)	11
Other nontraumatic intracerebral hemorrhage (I62)	0	0	0
Cerebral infarction (I63)	13 (61.9)	8 (38.1)	21
Not specified as hemorrhage or infarction (I64)	1 (50.0)	1 (50.0)	2
Subtotal	23 (63.9)	13 (36.1)	36
Outcome category			
Non-fatal	25 (73.5)	9 (26.5)	34
Fatal	3 (25.0)	9 (75.0)	12
Total	28 (60.9)	18 (39.1)	46

Table 9. Comparison of hospital-based and community-based registration.

	Number of CVD events	Interval (years)	Number of all-cause deaths	Average population size	Crude incidence (per 10,0000)
Time of occurrence					
Oct 2012–Sep 2013	10	1.00	5	1665.5	600
Oct 2013–Sep 2014	13	1.00	7	1659.5	783
Oct 2014–Sep 2015	12	1.00	9	1651.5	727
Oct 2015–Jun 2016	11	0.75	10	1642.0	893
Village or township office					
Kesirjia	3	3.75	4	145.0	552
Tarstark	7	3.75	5	209.5	891
Bitiworg	14	3.75	8	274.0	1363
Wutubulak	9	3.75	4	191.0	1257
Sarkamus	10	3.75	7	373.5	714
Duolart	3	3.75	2	269.0	297
Township office	0	3.75	1	190.5	0
Total	46	3.75	31	1652.5	742

Table 10. Distribution of events by time and place.

no new event was found. This could relate to a small population size, young age, and a low proportion of men. The incidence and mortality of acute cardiovascular events were highly affected by age. An incidence summit occurred in people aged 50–59 years (**Table 11**). In general, the crude rates of incidence and mortality for acute cardiovascular events were 742 and 194 per 100,000 people, respectively; the standardized rates were 926 and 272 per 100,000 people, respectively.

This part is also shown in our Chinese publication [15].

	Number by disease		**Number by outcome**		**Total**
	Cardiac event	**Stroke**	**Nonfatal**	**Fatal**	
Gender					
Male (%)	6 (60.0)	20 (55.6)	20 (58.8)	6 (50.0)	26 (56.5)
Female (%)	4 (40.0)	16 (44.4)	14 (41.2)	6 (50.0)	20 (43.5)
Incident age (years)					
< 40 (%)	1 (10.0)	2 (5.6)	2 (5.9)	1 (8.3)	3 (6.5)
40 ~ 49 (%)	1 (10.0)	7 (19.4)	6 (17.6)	2 (16.7)	8 (17.4)
50 ~ 59 (%)	3 (30.0)	11 (30.6)	10 (29.4)	4 (32.4)	14 (30.4)
60 ~ 69 (%)	2 (20.0)	7 (19.4)	8 (23.5)	1 (8.3)	9 (19.6)
70 ~ 79 (%)	0	9 (25.0)	8 (23.5)	1 (8.3)	9 (19.6)
≥ 80 (%)	3 (30.0)	0	0	3 (25.0)	3 (6.5)

Table 11. Distribution of events by gender and age.

4. Discussion

4.1. Epidemic of cardiovascular risk factors

The overall prevalence of cardiovascular risk factors was found to be high in this sample of Kazakh population, and varied markedly across occupational backgrounds. Compared with nomad and farmer groups, urban participants had more multiple cardiovascular risk factors and higher prevalence of dyslipidemia and obesity, while nomads possessed the highest prevalence of hypertension. The prevalence of diabetes mellitus was generally low in all subgroups which exhibited a separate status in these highly related indicators which normally coexist in cluster. Additionally, a higher prevalence of cardiovascular risk factors was associated with lower level annual family income and education attainment.

Previous studies on Kazakh populations considered Kazakh individuals as a single group, usually with comparisons to other ethnic groups [16–20]. Our study addressed a gap in intergroup variations in individual cardiovascular risk factor prevalence, which had several notable characteristics similar to previous work. First, Kazakh people were experiencing a strikingly higher rate of hypertension (50.1%); this prevalence is significantly higher than the national average (27.2% for a population aged 35 to 74 years) [18], higher than other ethnic groups such as Uygur (29.2%) and Han (30.2%) who account for 86% of total Xinjiang population, and also higher than previous reports for Kazakh adults (40.2%). Unfortunately, these people had a much poorer treatment and control of hypertension, compared with national average (28.8 vs. 82.9% for treatment of hypertension; 2.9 vs. 9.7% for BP control) [21]. In addition to differences in genetic backgrounds, dietary intake of high salt and high fat appeared to be major environmental factors that contributed to high BP in this ethnic group, especially for Kazakh nomads; this is supported by this study and our previous study [13]. Besides rare intake of vegetable and fruit, salty air-dried meat and milk-tea were their indispensable daily food and beverage. Estimated 24-h salt intake (20.6% of the person's salt intake came from drinking salty milk tea, a daily drink) with an average of 17.6 g/d was much higher than 12.4 g from WHO-CARDIAC study conducted in the same area (Kazakh as whole) in 2000 [22]. Salt-restriction, an easy, effective and affordable public health intervention, was needed urgently for these people. Second, urban participants had the highest prevalence of dyslipidemia compared with farmer and nomads groups, and this trend did not change following an increased age. Unlike some other studies showing that the prevalence of dyslipidemia in adult men changed with age like a "∩" shape [23–25], our results showed that young men possessed the highest prevalence of dyslipidemia and decreased significantly thereafter. For urban men, for example, the prevalence of dyslipidemia was 59.1% at age 30–44 years, 52.2% at age 45–59 years, and 33.3% at age ≥ 60 years. This trend may be explained by some social habits. In Kazakh, men rather than women had more chance to contact society, especially young men, they may be closely associated with men's social roles and have a higher chance to encounter unhealthy habits, including smoking, drinking (the prevalence of smoking and drinking was also at peak in this age period), and overeating as a result of social interaction, increasing the risk of dyslipidemia. With increasing age and reduced social interaction, awareness to protect one's health increases, leading to the reduction of dyslipidemia risk. For women, our results revealed a similar trend with other studies [23–25]. The prevalence of dyslipidemia in women initially decreased and subsequently increased, this trend might be closely related to changes in hormone levels [26]. Some studies indicated that sex hormone level was an independent risk factor for dyslipidemia [27]. Third, The overall prevalence of diabetes was generally low (1.56%) in this study, which was similar with previous Kazakh reports (1.47–3.65%) [28, 29], but much lower than 9.7% of the national average level [30]. Unlike previous studies, which reported that diabetes tended to be bundled with hypertension, and that there was substantial overlap between diabetes mellitus and hypertension in etiology and disease mechanisms, our results revealed that diabetes mellitus was a relatively independent disease, and 3.1% of hypertension patients had a coinstantaneous type 2 diabetes mellitus. The mechanism why Kazakh people have such low prevalence remains unclear; further study should be warranted.

Assessing the pattern of risk factors for CVDs in the Kazakh population is important for several reasons. First, despite rapid urbanization in China, most of Chinese people still live in rural areas, especially in ethnic minority communities. A Kazakh level of urbanization is 15.3%, which is much lower than the national average level (36.9%) [31]. Contrary to the prevailing belief among policy makers that cardiovascular risk factors primarily afflict the urban affluent, the burden of cardiovascular risk factors in rural areas of developing countries is currently heavy and rising [32], where people in resource-poor areas have less access to preventive services, less access to medication and procedures, and more exposure to risk factors. Understanding the distributions of cardiovascular risk factors in these populations is vital for planning public health responses. Second, China is a multiethnic country, with Tibetans and Mongolians, who live in Xinjiang, Tibet, Qinghai, and Inner Mongolia, which account for one-third of the total area of China; they have a lifestyle similar to that of Kazakh people. In addition to the possible effects of genetic background differences, environmental stress and lifestyle characteristics may have important effects on human physiology. These data provide important insights for the development of chronic diseases in populations who have similar living, environmental, and cultural exposures. Third, such data may contribute to our understanding of disease etiology by comparing risk profiles of naturally occurring groups. For example, persons with just one cardiovascular risk factor were more common in nomads or farmers, whereas those with ≥ 2 (for women ≥ 3) risk factors were more common in city people, which exhibits a clear way (from nomad to farmer to city people) showing that Kazakh people are experiencing lifestyle changes compared to the simple nomadic lifestyle and dietary habits; these changes are more conspicuous among young people. The genetic homogeneity of these groups tends to help isolate the role of environmental and lifestyle factors in the etiology of various chronic diseases.

4.2. Registration of acute cardiovascular events

Our preliminary work on registration of acute cardiovascular events has two main findings.

This work is highly complicated and needs coordination from public health and clinical specialists. Searching all probable incident clues and making a diagnosis for targeted cases are comparably important. To accumulate experience for a national surveillance of acute cardiovascular events that are not based on a cohort, we initially used a follow-up-based method by telephone. Hospital-based and community-based searches for CVD clues were synchronously employed, as suggested by the WHO MONICA project [33]. In this study, village physicians played an important role. They were familiar with health problems of local people and could provide some crude information on our interest after simple training. This reduced false negatives which might be caused due to seeing a doctor out of the local place, failing to search files in hospitals, and occurrence of death before arriving at hospital or at home. During a work stage in hospital, multiple files indexed by one patient code were boring; this was particularly frequent for ischemic stroke. Unfortunately, we could not directly access information on acute symptom, diagnostic evidence, and time of occurrence in a discharge card that usually is used by a hospital information system; this was serious in stroke that had a good match between ICD-10 code and a clinical diagnosis. With this situation, a disease history described in the medical records need to be read.

Studies related to incidence or mortality of acute cardiovascular events in Kazakh people are currently scarce. This population has a much higher incidence and mortality of acute cardiovascular events, compared with an average level in China. According to a national survey conducted in people aged 20 years or older across China in 2010, the incidence and mortality of stroke were 246.8 and 114.8 per 100,000 people standardized to China Census Population 2010, respectively [34]. The incidence of AMIs is unknown at the same time; however, related guidelines indicated that the ratio between AMIs and stroke was likely appropriate 1:5 [6] and this ratio was consistent with our study. Our study showed a 1.6 ratio of ischemic stroke compared to hemorrhagic stroke; this was much lower than the national level (approximately equal to 3) [34] that could be related to a much higher prevalence of hypertension in the Kazakh population. The age summit for acute cardiovascular events was 50–59 years in our sample population, younger than the mean age of people with prevalent stroke (66.4 years) in the national survey.

4.3. Strength, limitation, and its future

A key strength of this study is that we have a high-quality study design and practice with a high response rate which helps to ensure good internal validity and a reasonable approach to extrapolation of study results. However, a number of limitations should be kept in mind when assessing the evidence provided by our study. First, the participants in the urban group are relatively younger, and have a higher SES compared with other urban residents; therefore, the prevalence of cardiovascular risk factors may be underestimated. Second, because the study is community-based, the problem of clustering of risk factors within families could lead to some error in risk estimation, future research will be needed in this aspect. Nevertheless, our study population was from a town; this may lead to a limitation for generalizing our results, but this should not compromise the internal validity of our findings.

Due to a limited study year, we do not further calculate the incidence and mortality in different occupational populations. The next stage of follow-ups will be conducted. Nevertheless, we have established a population base with a follow-up system for cardiovascular outcomes and a good relationship with local governments. The Mother Program, aiming to reduce salt intake, is currently being conducted by local department of health and population. First, village physicians, women village leaders, and teachers in this town, who participate in an intervention for villagers, will be trained by seminars, textbooks, and multimedia. Second, all women will participate in multiple trainings about knowledge of hypertension and its prevention as well as how to reduce daily salt intake and improve diet. For a better effect, we will visit each family and help them achieve a goal of salt-restriction. Third, two-hour classes on hypertensive healthcare will be added per term in all schools of this town. We will have a rounded evaluation including all baseline contents every other year. During a further follow-up, we schedule the goal at the end of this study including lowering daily salt intake to 10 g, lowering blood pressure by 10/5 mmHg, and a significant reduction in incidence due to cardiovascular outcomes. Researchers, clinical physicians, and government officials are involved in this program team.

We believe that long-term effects of this lifestyle improvement will benefit not only male and female all-age Kazakh population but also next Kazakh generations. Also, our quality work will provide experience to combine medicine-based evidence with current nationwide policies, such as China National Herdsmen Settling Program covering two-thirds of land territory in China, for benefiting related ethnic minorities, such as Tibetan and Mongolian people.

5. Conclusions

In conclusion, findings from the CAKH study demonstrate the pervasive burden of cardiovascular risk factors and related acute cardiovascular events and an urgent need for controlling and preventing these risk factors in Kazakh population, especially BP in Kazakh nomads.

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References

[1] Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study. Lancet. 2004;**364**(9438):937-952. DOI: 10.1016/S0140-6736(04)17018-9

[2] O'Donnell MJ, Chin SL, Rangarajan S, Xavier D, Liu L, Zhang H, Rao-Melacini P, Zhang X, Pais P, Agapay S, Lopez-Jaramillo P, Damasceno A, Langhorne P, McQueen MJ, Rosengren A, Dehghan M, Hankey GJ, Dans AL, Elsayed A, Avezum A, Mondo C, Diener HC, Ryglewicz D, Czlonkowska A, Pogosova N, Weimar C, Iqbal R, Diaz R, Yusoff K, Yusufali A, Oguz A, Wang X, Penaherrera E, Lanas F, Ogah OS, Ogunniyi A, Iversen HK,

Malaga G, Rumboldt Z, Oveisgharan S, Al Hussain F, Magazi D, Nilanont Y, Ferguson J, Pare G, Yusuf S; INTERSTROKE Investigators. Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): A case-control study. Lancet. 2016;**388**(10046):761-775. DOI: 10.1016/S0140-6736(16)30506-2

[3] Hou L, Zhang M, Han W, Tang Y, Xue F, Liang S, Zhang B, Wang W, Asaiti K, Wang Y, Pang H, Wang Z, Wang Y, Qiu C, Jiang J. Influence of salt intake on association of blood uric acid with hypertension and related cardiovascular risk. PLoS One. 2016;**11**(4):e0150451. DOI: 10.1371/journal.pone.0150451

[4] Kawano Y, Tsuchihashi T, Matsuura H, Ando K, Fujita T, Ueshima H, Working Group for Dietary Salt Reduction of the Japanese Society of Hypertension. Report of the Working Group for Dietary Salt Reduction of the Japanese Society of Hypertension: (2) Assessment of salt intake in the management of hypertension. Hypertension Research. 2007;**30**(10):887-893

[5] The Chinese Work Group on Blood Pressure Measurements. Chinese guidelines on blood pressure measurements. Journal of Clinical Hypertension. 2011;**19**(12):1101-1114. Chinese

[6] Writing Group of 2010 Chinese Guidelines for the Management of Hypertension. 2010 Chinese guidelines for the management of hypertension. Journal of Clinical Hypertension. 2011;**19**(8):1101-1114. Chinese

[7] Joint Committee for Developing Chinese Guidelines on Prevention and Treatment of Dyslipidemia in Adults. Chinese guidelines on prevention and treatment of dyslipidemia in adults. Chinese Journal of Cardiology. 2007;**35**(5):390-419. Chinese

[8] Hou L, Han W, Jiang J, Liu B, Wu Y, Zou X, Xue F, Chen Y, Zhang B, Pang H, Wang Y, Wang Z, Hu Y, Li J. Passive smoking and stroke in men and women: A national population-based case-control study in China. Scientific Reports. 2017;**7**:45542. DOI: 10.1038/srep45542

[9] Wu Z, Yao C, Zhao D, Wu G, Wang W, Liu J, Zeng Z, Wu Y. Sino-MONICA project: A collaborative study on trends and determinants in cardiovascular diseases in China, Part I: Morbidity and mortality monitoring. Circulation. 2001;**103**(3):462-468

[10] Thygesen K, Alpert J, Jaffe A, Simoons M, Chaitman B, White H; Writing Group on Behalf of the Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction. Third universal definition of myocardial infarction. Circulation. 2012;**126**(8):2020-2025. DOI: 10.1161/CIR.0b013e31826e1058

[11] Chugh SS, Reinier K, Teodorescu C, Evanado A, Kehr E, Al Samara M, Mariani R, Gunson K, Jui J. Epidemiology of sudden cardiac death: Clinical and research implications. Progress Cardiovascular Disease. 2008;**51**(3):213-228. DOI: 10.1016/j.pcad.2008.06.003

[12] Jiang J, Zhang B, Zhang M, Xue F, Tang Y, Liang S, Hou L, Wang W, Han W, Asaiti K, Nasca PC, Wang Y, Pang H, Wang Z, Wang Y, Qiu C. Prevalence of conventional cardiovascular disease risk factors among Chinese Kazakh individuals of diverse occupational

backgrounds in Xinjiang China. International Journal of Cardiology. 2015;**179**:558-560. DOI: 10.1016/j.ijcard.2014.10.077

[13] Han W, Hu Y, Tang Y, Xue F, Hou L, Liang S, Zhang B, Wang W, Asaiti K, Pang H, Wang Z, Wang Y, Zhang M, Jiang J. Relationship between urinary sodium with blood pressure and hypertension among a Kazakh community population in Xinjiang, China. Journal of Human Hypertension. 2017;**31**(5):333-340. DOI: 10.1038/jhh.2016.83

[14] Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD; Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction, Katus HA, Lindahl B, Morrow DA, Clemmensen PM, Johanson P, Hod H, Underwood R, Bax JJ, Bonow RO, Pinto F, Gibbons RJ, Fox KA, Atar D, Newby LK, Galvani M, Hamm CW, Uretsky BF, Steg PG, Wijns W, Bassand JP, Menasché P, Ravkilde J, Ohman EM, Antman EM, Wallentin LC, Armstrong PW, Simoons ML, Januzzi JL, Nieminen MS, Gheorghiade M, Filippatos G, Luepker RV, Fortmann SP, Rosamond WD, Levy D, Wood D, Smith SC, Hu D, Lopez-Sendon JL, Robertson RM, Weaver D, Tendera M, Bove AA, Parkhomenko AN, Vasilieva EJ, Mendis S. Third universal definition of myocardial infarction. Circulation. 2012;**126**(16):2020-2035. DOI: 10.1161/CIR.0b013e31826e1058

[15] Hou L, Han W, Tang Y, Xue F, Liang S, Wang W, Zhang B, Pang H, Wang Y, Wang Z, Hu Y, Wang L, Zhang M, Jiang J. A pilot study to explore a registry method for acute cardiovascular events. National Medicine Journal of China. 2017;**97**(13):1024-1029. Chinese

[16] Wu Y, Huxley R, Li L, Anna V, Xie G, Yao C, Woodward M, Li X, Chalmers J, Gao R, Kong L, Yang X, China NNHS Steering Committee; China NNHS Working Group. Prevalence, awareness, treatment, and control of hypertension in China: Data from the China National Nutrition and Health Survey 2002. Circulation. 2008;**118**(25):2679-2686. DOI: 10.1161/CIRCULATIONAHA.108.788166

[17] Gu D, Reynolds K, Wu X, Chen J, Duan X, Muntner P, Huang G, Reynolds RF, Su S, Whelton PK, He J; InterASIA Collaborative Group. The International Collaborative Study of Cardiovascular Disease in ASIA. Prevalence, awareness, treatment, and control of hypertension in China. Hypertension. 2002;**40**(6):920-927

[18] Ma X, Zhang M, Guo S, Ma R, Ding Y, Guo H, Zhang J, Niu Q, Li S, Liu J, Xu S. Prevalence of hypertension in Uygur, Kazakhs and Han people in rural areas of Xinjiang. Chinese Journal of Hypertensions. 2013;**21**(12):1164-1168. Chinese

[19] Zhai F, He Y, Wang Z, Hu Y. Status and characteristic of dietary intake of 12 minority nationalities in China. Wei Sheng Yan Jiu. 2007;**36**(5):539-541. Chinese

[20] Li J, Wang L, Li Y, Bi Y, Jiang Y, Mi S, Dai M, Xu Y, Ning G, Zhao W. Epidemiologic characteristics of dyslipidemia in Chinese adults 2010. Zhonghua Yu Fang Yi Xue Za Zhi. 2012;**46**(5):414-418. Chinese

[21] Li Y, Yang L, Wang L, Zhang M, Huang Z, Deng Q, Zhou M, Chen Z, Wang L. Burden of hypertension in China: A nationally representative survey of 174,621 adults. International Journal of Cardiology. 2017;**227**:516-523. DOI: 10.1016/j.ijcard.2016.10.110

[22] Liu L, Liu L, Ding Y, Huang Z, He B, Sun S, Zhao G, Zhang H, Miki T, Mizushima S, Ikeda K, Nara Y, Yamori Y. Ethnic and environmental differences in various markers of dietary intake and blood pressure among Chinese Han and three other minority peoples of China: Results from the WHO Cardiovascular Diseases and Alimentary Comparison (CARDIAC) study. Hypertension Research. 2001;**24**(3):315-322

[23] Guo SX, Ma RL, Guo H, Ding YS, Liu JM, Zhang M, Zhang JY, Xu SZ, Li SG, Rui DS, Niu Q, Li YP. Epidemiological analysis of dyslipidemia in adults of three ethnicities in Xinjiang, China. Genetics and Molecular Research. 2014;**13**(2):2385-2393. DOI: 10.4238/2014.April.3.11

[24] Joshi SR, Anjana RM, Deepa M, Pradeepa R, Bhansali A, Dhandania VK, Joshi PP, Unnikrishnan R, Nirmal E, Subashini R, Madhu SV, Rao PV, Das AK, Kaur T, Shukla DK, Mohan V; ICMR-INDIAB Collaborative Study Group. Prevalence of dyslipidemia in urban and rural India: The ICMR-INDIAB study. PLoS One. 2014;**9**(5):e96808. DOI: 10.1371/journal.pone.0096808

[25] Cabrera M, Sánchez-Chaparro MA, Valdivielso P, Quevedo-Aguado L, Catalina-Romero C, Fernández-Labandera C, Ruiz-Moraga M, González-Santos P, Calvo-Bonacho E; ICARIA (Ibermutuamur CArdiovascular RIsk Assessment) Study Group. Prevalence of atherogenic dyslipidemia: Association with risk factors and cardiovascular risk in Spanish working population. "ICARIA" study. Atherosclerosis. 2014;**235**(2):562-569. DOI: 10.1016/j.atherosclerosis.2014.05.960

[26] Sowers MR, Randolph J Jr, Jannausch M, Lasley B, Jackson E, McConnell D. Levels of sex steroid and cardiovascular disease measures in premenopausal and hormone-treated women at midlife: Implications for the "timing hypothesis". Archives of Internal Medicine. 2008;**168**(19):2146-2153. DOI: 10.1001/archinte.168.19.2146

[27] Ali ZA, Al-Zaidi MS. The association between body mass index, lipid profile and serum estradiol levels in a sample of Iraqi diabetic premenopausal women. Oman Medical Journal. 2011;**26**(4):263-266

[28] Yang YN, Xie X, Ma YT, Li XM, Fu ZY, Ma X, Huang D, Chen BD, Liu F, Huang Y, Liu C, Zheng YY, Baituola G, Yu ZX, Chen Y. Type 2 diabetes in Xinjiang Uygur autonomous region, China. PLoS One. 2012;**7**(4):e35270. DOI: 10.1371/journal.pone.0035270

[29] Tao Y, Mao X, Xie Z, Ran X, Liu X, Wang Y, Luo X, Hu M, Gen W, Zhang M, Wang T, Ren J, Wufuer H, Li L. The prevalence of type 2 diabetes and hypertension in Uygur and Kazak populations. Cardiovascular Toxicology. 2008;**8**(4):155-159. DOI: 10.1007/s12012-008-9024-0

[30] Yang W, Lu J, Weng J, Jia W, Ji L, Xiao J, Shan Z, Liu J, Tian H, Ji Q, Zhu D, Ge J, Lin L, Chen L, Guo X, Zhao Z, Li Q, Zhou Z, Shan G, He J; China National Diabetes and Metabolic Disorders Study Group. Prevalence of diabetes among men and women in China. The New England Journal of Medicine. 2010;**362**(12):1090-1101. DOI: 10.1056/NEJMoa0908292

[31] National Bureau of Statistics of China. The data of the fifth population census in China. 2000. Available from: Http://www.stats.gov.cn/tjsj/ndsj/renkoupucha/2000pucha/pucha.htm

[32] Myers L, Mendis S. Cardiovascular disease research output in WHO priority areas between 2002 and 2011. Journal of Epidemiology and Global Health. 2014;**4**(1):23-28

[33] Tunstall-Pedoe H. Problems with criteria and quality control in the registration of coronary events in the MONICA study. Acta Medica Scandinavica. 1988;**728**(Suppl.):17-25

[34] Wang W, Jiang B, Sun H, Ru X, Sun D, Wang L, Wang L, Jiang Y, Li Y, Wang Y, Chen Z, Wu S, Zhang Y, Wang D, Wang Y, Feigin VL; NESS-China Investigators. Prevalence, incidence and mortality of stroke in China: Results from a nationwide population-based survey of 480,687 adults. Circulation. 2017. DOI: 10.1161/CIRCULATIONAHA.116.025250